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GENERIC MEASUREMENT RISK ASSESSMENT OF BIOMETHANE INJECTION INTO GAS DISTRIBUTION SYSTEMS

1 INTRODUCTION

The Energy Market Issues for Biomethane Projects (EMIB) Review Group has been convened to provide a forum for informed debate on the potential barriers to the commercial development of biomethane projects within the energy market and the appropriate means of addressing such barriers. One of the potential barriers identified by the EMIB Review Group is the potential for excessive or unnecessary measurement requirements to be specified, based on needs at entry points for conventional natural gas, rather than those of a, notionally less complex, biomethane. The EMIB therefore requested that measurement risk assessment for a generic biomethane grid injection facility, in accordance with the approach developed and employed by National Grid for assessment of natural gas entry at its gas transmission and gas distribution systems.

The generic biomethane injection facility would be produced by treating raw biogas made by anaerobic digestion. Because the facility is generic the exact technology and equipment for gas treatment to convert the raw biogas to biomethane, CV enrichment and odorisation have not been specified. The risk assessment was not specific to any of a particular entry point although in general it was assumed that injection would be within a Gas Distribution System (currently this is considered to be below 7 bar, although the potential broadening of scope of IGE/TD/3 to pressures up to 16 barg was considered when assessing water dew temperature measurement risk). The risks identified - and hence any conclusions drawn or recommendations made - can therefore only be considered indicative; risk assessment specific to particular facilities for treatment of a known biogas using identified processes and equipment is recommended.

2 METHODOLOGY

The procedure for risk assessment was based on National Grid's T/PM/GQ/8 Management Procedure for Assessing the Requirement for Gas Quality, Calorific Value and Flow Measurement Systems. GQ/8 provides a structured approach to identification of causes of deviation from the design intention of parameters identified in the relevant Network Entry Agreements. Deviations were ranked according to risk (assessed as the product of impact and likelihood) and, where risk of significant deviation is identified, measurement provision is recommended. A summary of the approach employed is given in Appendix A.

3 RISK ASSESSMENTS

A record of the risk assessment is provided in Appendix B. The risk assessment was not specific to any of a particular entry point and is therefore considered generic risks associated with biomethane injection, although the assumption made during risk assessment was that point of injection would be close to MP-LP pressure reduction with little opportunity for active blending.

4 DISCUSSION AND CONCLUSIONS

1) The biomethane after gas treatment and enrichment (if required) is likely to contain oxygen in excess of the 0.2 mol% limit required by the Gas Safety (Management) Regulations. Removal of oxygen is considered prohibitively expensive. Application of an oxygen limit at this level may not be appropriate in the distribution system in view of the absence of assets that are prone to high partial pressures of oxygen (e.g. molecular sieves at LNG storage sites, aquifer storage systems). The remaining risk is that of enhanced corrosion rate by elevated oxygen levels in the presence of liquid water in metallic mains. Currently the HSE have indicated that exemption from this aspect of the GS(M)R may be possible on a case-by-case basis, provided adequate safeguards are maintained. In the longer term an upwards revision of the oxygen limit in the GS(M)R is under consideration. Continual measurement and alarm management is recommended.

2) The risk assessment panel assumed that the gas transporter would be directed by Ofgem to determine the calorific value (CV) of the biomethane injected and therefore that the CV measurement will have to be performed with equipment approved by Ofgem. Currently this is limited to the Daniels model 500 and 700 process analysers (the “Danalyzers”) although

potentially lower-cost devices may prove to be acceptable to Ofgem[1]. CV determination devices currently represent a significant fraction of the installed cost of an injection point.

3) Risk assessment identified that if Ofgem were to direct the gas transporter to determine CV of the biomethane injected then the biomethane would inevitably become the lowest source for the a charging area and hence would have significant impact in the frequency of capping of the charging area Flow Weighted Average CV (FWACV). Under this scenario, application of a target CV achieved through enrichment of the treated gas with commercial propane or by blending with other gases, may need to be agreed. Continual measurement and alarm management is recommended.

4) Risk assessment identified that when enrichment of biomethane with LPG is practiced there is potential for significant deviations in the Wobbe index (upper limit), incomplete combustion factor and sooting index. Insufficient removal of carbon dioxide from biogas could lead to deviation in the Wobbe index (lower limit). Continual measurement and alarm management of these parameters is recommended. The accuracy requirements of such measurements will depend on whether enrichment to achieve a target CV close to the anticipated FWACV is practiced, and the magnitude of such a target CV. If a target CV is set then expected values of Wobbe index, ICF and SI would be relatively far away from GS(M)R limit values and accuracy requirements may be less than if a target CV was not set.

5) Risk assessment identified significant risk from deviation in delivery temperature when compression or pressure reduction is practiced. In practice the likelihood of deviation would depend on the pressure drop/rise and the pipe length between pressure reduction/compression and injection. Continual measurement and alarm management should be assessed for specific entry points.

6) Risk assessment identified significant risk from under-odorisation. Installation of an odour intensity test point downstream of the injection point and inclusion of this point in routine monitoring according to T/MP/GQ/2 is recommended.

7) Hydrogen sulphide content of the raw biogas is likely to be high and hence risk assessment identified some potential for significant deviation in hydrogen sulfide content. Continual measurement and alarm management is recommended.

8) Network entry agreements currently specify a water dew temperature requirement of -10^{o}C at 85 barg. Risk assessment identified significant deviation from this requirement and continual measurement and alarm management is recommended. Risk assessment also identified that a less stringent requirement in water dew temperature may be more appropriate for injection of biomethane into Gas Distribution Systems. This is discussed in more detail in a separate report[2].

9) Risk assessment identified that there may be significant risk of deviation in organo-halides content. Current instrumentation limits measurement to laboratory analysis of spot samples. A more detailed gas analysis of actual raw biogas for specific biomethane entry applications and assessment of the appropriate measurement frequency is therefore recommended.

10) Risk assessment identified risks from bio-hazards to be unquantifiable in the absence of detailed assessment of the raw gas. Further work in this area is recommended. The work sponsored by the Environment Agency on development of an End of Waste QP may recommend values and the output should feed into the setting of appropriate limits.

11) Risk assessment identified the need for further work to be carried out to assess the combined impact of carbon dioxide, hydrogen sulphide, oxygen and liquid water on corrosion rate of gas mains. Following this the need for continual monitoring of carbon dioxide should be re-assessed.

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[1] The most appropriate accuracy of CV determination devices for biomethane injection applications is another potential barrier that is being considered by the EMIB Review Group.

[2] D.F.Lander. ……

12) Risk assessment identified that there may be significant risk of deviation in contaminants content. Current instrumentation limits measurement to laboratory analysis of spot samples. A more detailed gas analysis of actual raw biogas for specific biomethane entry applications and assessment of the appropriate measurement frequency is therefore recommended. More work required to set limits of specific contaminants, such as siloxanes. The work sponsored by the Environment Agency on development of an End of Waste QP may recommend values and the output should feed into the setting of appropriate limits.

13) If Ofgem were to deem the injection of biomethane to be an input into the charging area then daily volume would have to be determined to an accuracy "requisite to the calculation of the Flow Weighted Average CV". Current policy is for daily volumes at new entry points to be measured to an uncertainty of 1.0% (in converted volume) and 1.1% (in energy). However, this policy is set in the context of significant daily gas volumes (e.g. NTS offtakes of around 1 million m^3 or more). A more modest accuracy such as that from installation to IGEM/GM/8 may be considered more appropriate. This issue should be considered by the EMIB Review Group.

14) Network entry agreements currently specify a range in calorific value of 36.9 – 42.3 MJ/m^3. The appropriateness of such calorific value range of in the network entry agreement should be reviewed, as gas interchangeability is covered by the Wobbe number specification.

15) Risk assessment did not identify any special requirements for monitoring hydrocarbon dew temperature, total sulphur content, hydrogen, inerts or radioactivity. A more detailed gas analysis of actual raw biogas for specific biomethane entry applications and assessment of the appropriate measurement frequency is therefore recommended.

APPENDIX A – SUMMARY OF RISK ASSESSMENT APPROACH

EMIB Experts Group Meeting #2

21st October 2011: Generic Measurement Risk Assessment

Procedure Summary – parameters and deviations

- Decide parameters and limit values against which assessment will be performed, typically:
  - Gas Quality
  - Temperature
  - Pressure
- For each parameter in turn:
  - Compare limit value with design or expected value
  - Assess deviations from the design/expected value
    - Causes: e.g. gas source, blending, processing
    - Magnitude of deviation
    - Speed of deviation

Procedure Summary - impact

§ Consider the IMPACT of any non-compliance:

- Regulatory obligations
- Safety of consumers, members of public and workers
- Safe operation of the system or appliances
- Commercial impact
- Primary (at the entry point) and Secondary (elsewhere)

§ Assign an IMPACT RATING

- 1: Minor or zero financial impact
- 2: Medium financial impact
- 3: Failure to comply with legislative/regulatory obligations and/or major financial impact

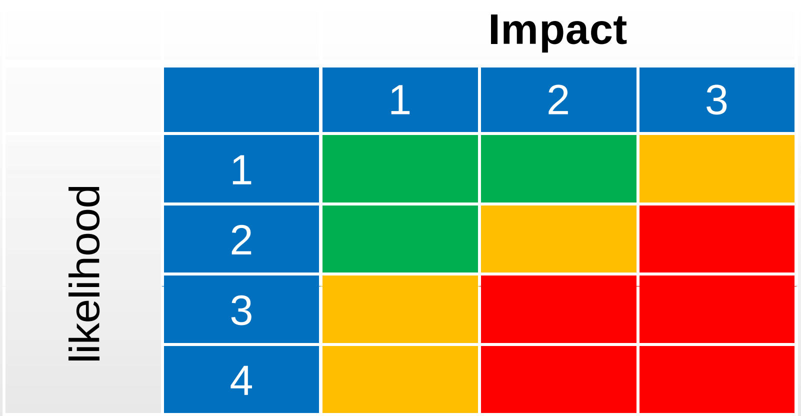
Procedure Summary - likelihood

- Consider the LIKELIHOOD of any non-compliance
- Assign a LIKELIHOOD RATING
  - 1: Event rarely or never occurs (“less than annual occurrence”)
  - 2: 1-5 events per annum (“annual occurrence”)
  - 3: Around 12 events per annum (“monthly occurrence”)
  - 4: Around 50-300 events per annum (“daily or weekly occurrence”)

Procedure Summary - risk

§ Assign a RISK rating:

- Risk rating = Impact rating x Likelihood rating
- 6-12: High risk
  - (consider continuous monitoring)
- 3-4: Medium risk
  - (consider spot sampling)
- 1-2: Low risk
  - (consider initial, spot sampling)



Procedure Summary - extras

- Specify specific measurement systems, based on perceived risk
  - required measurement range and accuracy
  - required frequency
- Consider (initial) operational alarms
  - type and set point
- Other control measures
  - Automatic shut off, etc.

Generic Risk Assessment - biomethane entry to grid

§ Site details

- Generic Biogas production facility.
- Gas treatment to produce biomethane and enrichment and odorisation to pipeline quality.

§ Process description (assumptions)

- Raw biogas is produced through anaerobic digestion at AD plant (substrate unspecified), followed by partial cleanup.
- For network injection, additional treatment is employed to produce a treated biomethane assumed to comprise largely methane(96%), carbon dioxide(2%), nitrogen(1.2%) and oxygen(0.8%).
- Gas is dried prior to injection (dew temperature -40C at what pressure?).
- Site is assumed to be directed by Ofgem under Gas(COTE)R and biomethane is assumed to be enriched with commercial propane to a target CV of 39.5 MJ/m3.

APPENDIX B – RECORD OF RISK ASSESSMENT

Risk Assessment of Gas Entry Conditions at Connection to an NTS/LTS/GDS

Reference	Risk Assessment_Biomethane_generic
Date of Assessment	21st October 2011, 3rd November 2011
Assessment conducted by	Dave Lander (Dave Lander Consulting Limited), Stephen Skipp (SGN), Barry Purl (SGN), Stuart Gibbons (National Grid), Steve Howell (SGN), Ian Taylor (NGN) and Colin Stock (WWU).
Site Details	Generic Biogas production facility. Gas treatment to produce biomethane and enrichment and odorisation to pipeline quality.
Delivery Point Details	
Delivery capacity SCM/day	Base case 100 m3/h. Higher flow 1000 m3/h to be considered?
Delivery capacity GWh/day	0.0165
Fuel gas or own use gas	tbc
MPR number	
Annual Offtake Quantity GWh/year	4.56
Maximum flowrate SCM/day	1153
Minimum flowrate SCM/day	0

Description of Associated/Upstream Blending or Processing Facilities

(a) Raw gas is produced through anaerobic digestion at AD plant (substrate unspecified), followed by partial cleanup. (b) For network injection, additional treatment would be employed to produce a treated gas assumed to comprise largely methane(96%), carbon dioxide(2%), nitrogen(1.2%) and oxygen(0.8%). Gas would be dried prior to injection (dew temperature -40C at 1 atm). (c) Site is assumed to be directed by Ofgem under Gas(COTE)R and biomethane is assumed to be enriched with commercial propane to a target CV of 39.5 MJ/m3.

Statutory documents:

Gas Safety (Management) Regulations, Gas (Calculation of Thermal Energy) Regulations, Radioactive substances Act. Pressure Systems Safety Regulations, Pipeline Safety Regulations, COSHH, Health and Safety at Work Act

Industry documents:

Uniform Network Code, Safety case for the relevant GDN, T/PM/GQ/8, Long Term Development Plan for each GDN, Marcogaz Guidance Note on Biogas, draft CEN/TC 234 WG9 Technical Report.

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Risk_Assessment_Biomethane_generic

No.	Parameter	Network Entry Requirement	Requirement source	Expected Value	Expected value notes	Deviation magnitude and speed	Deviation Notes	Cause	Cause notes	Impact rating (1 - 3)	Impact notes	Likelihood rating (1 - 4)	Likelihood notes	Risk rating (1 - 12)	Conclusions, control measures, comments.
9.0	Oxygen	<0.2 mol%	GDN LTDS and GS(M)R	0.5-0.8% typical?		>0.2 mol%		raw gas contains oxygen		3		4		12	Seek exemption to permit levels greater than 0.2%. Long term solutions via change of GS(M)R might be possible in the long term. Exemption may still require continuous monitoring?
12.1	Wobbe No	51.41 to 47.2 MJ/m3	GDN LTDS and GS(M)R	47.2 MJ/m3 if GSMR compliance is driver, 48-49 MJ/m3 if CV is the driver	Depends on inerts and driver (eg. CO2 removal to 1.5% might be suffcient to meet GSMR)	>51.41 MJ/m3		Over-enrichment	credible (going from 5% to 10% addition would breach upper WN limit)	3		3	Assuming that enrichment is practiced - low inerts and blending might be sufficient to avoid enrichment	9	Continuous monitoring recommended when enrichment is practiced
12.2	Wobbe No	51.41 to 47.2 MJ/m4	GDN LTDS and GS(M)R	47.2 MJ/m3 if GSMR compliance is driver, 48-49 MJ/m3 if CV is the driver	Depends on inerts and driver (eg. CO2 removal to 1.5% might be suffcient to meet GSMR)	<47.2 MJ/m3		CO2 removal failure or enrichment failure		3		3	Based on experiences at Grain. If WN is the driver likelihood of non compliance is greater	9	Continuous monitoring recommended. Whether CV or GSMR is the driver will affect how close to GSMR limit the actual WN expected.
13.0	ICF	<0.48	GDN LTDS and GS(M)R	<0.48		>0.48		Over-enrichment	credible (going from 5% to 10% addition would breach upper WN limit)	3		3	Assuming that enrichment is practiced - low inerts and blending might be sufficient to avoid enrichment	9	Continuous monitoring recommended when enrichment is practiced
14.0	SI	<0.60	GDN LTDS and GS(M)R	<0.60		>0.60		Over-enrichment	credible (going from 5% to 10% addition would breach upper WN limit)	3		3	Assuming that enrichment is practiced - low inerts and blending might be sufficient to avoid enrichment	9	Continuous monitoring recommended when enrichment is practiced
15.3	Gross CV	To not trigger FWACV cap	Enrichment to a CV target is likely. Some locations may permit blending, provided comingled CV can be measured and directed	Agreed target CV	If enrichment then the target CV after enrichment will be > LSCV. If blending, then the target CV will depend on the blending capability.	Situation such that FWACV cap comes into force		Enrichment failure, lack of blending gas, treatment problems, change in biogas composition (more inerts)		3	Daily CV at site becomes the LSCV and cap is triggered for that day	3		9	Continuous monitoring recommended
1.0	Delivery Temperature	1 - 38C (LTDS) 0-20C (PE systems)	GDN LTDS TD/3 (PE)	0 to 15C	Assumed pressure reduction or compression and length of underground pipe before entry point. Check water temperature from water wash systems	>20C		Compression prior to entry into above 7 bar system. Solar gain from stationary gas store? Hot propane?	Moderation after compression by length of pipe is main concern and is site specific. Check propane vaporiser -	3	Impacts on integrity of the system	2	Assumed system is designed to achieve 20C or less, so deviation is because of failure	6	Design should incorporate monitoring and alarm when compression is involved. Mitigation by pipeline length to be considered.
2.0	Delivery Temperature	1 - 38C (LTDS) 0-20C (PE systems)	GDN LTDS TD/3 (PE)	0 to 15C	Assumed pressure reduction or compression and length of underground pipe before entry point. Check water temperature from water wash systems	<0C		Pressure reduction and insufficient or failed pre-heat. Pressure reduction immediately after injection	Assuming J-T coefficient of 0.5 C/bar then 2 bar reduction would reduce temperature from 0 to -1C	3	Impacts on integrity of the system	2	Causes tend to be failure or insufficient design	6	Design should consider monitoring and alarm when excessive pressure reduction is involved. TD/3 suggests that PE pipe test temperature is normally 0C and that alternative test test temperatures should be considered if operation below 0C is expected. Pipeline length between pressure reduction and injection point will mitigate.
4.1	Odorant	6mg/m3 +/- 2 at DNO request (LTDS) may wish for 4-10 mg/m3 with normally 6 mg/m3	GDN LTDS	6mg/m3 variation will be dependent upon exact type of odoriser	Check likely type of odoriser in use	Low or no odorant at System Entry Point		Failure of odorant injection. Incorrect/failed flow signal on direct control systems		3		2	Will depend on the degree of redundancy, which may be dictated by the criticality of the entry point (i.e will it be the dominant source of gas for some consumers)	6	Suitable primary test point to be identified. Incorporate in routine monitoring. Critical sites might demand monitoring of injection rate/integrated rate. Might consider heirarchy of design and monitoring (twin/single stream and monitoring)
6.0	H2S	<5 mg/m3	GDN LTDS and GS(M)R	<5 mg/m3		>5mg/m3	Biogas could contain well in excess of 5 mg/m3 (2000-20000)	Failure of treatment plant, changes in feedstock		3		2	Depends on type of cleanup process and feedstock and variation in feedstock plant failure unlikely to be a monthly occurrance	6	Continuous monitoring is required. Accuracy and ownership to be discussed
11.0	Water dew temp	<-10oC at 85 barg more appropriate requirement might be -10C at maximum pressure	GDN LTDS	-40C at 1 atm (Sonntag) equivalent to -1.4C at 85 barg		>-10oC at 85 barg, or whatever value is in specification	Actual limit value to be decided based on prospect for re-compression or direct LTS	Process plant failure		3		2		6	Continuous monitoring recommended. The dew temperature requirement could be relaxed. See reparate report.

20.0 Organo Halides	<=1.5 mg/m3	TYS, LTDS	Further information required		Contains significant organo halides		Process failure		3	CHeck regulatory drivers	2		6	Technology prevents continuous monitoring so site specific spot sampling freqency would need to be assessed.
22.0 Bio-hazards	Free of significant bio-hazards		Free of significant bio-hazards		Contains significant bio-hazards		Failure in gas treatment			3		2	6	Risk is specific to source substrate. Check biohazards of raw biogas.
18.0 CO2	CO2 <=2.5% (molar)	Modification 0049 to UNC	<=2%		>2.5% (molar) CO2		Gas processing failure		2	Need to asses the impact: high CO2 would increase corrosion rate if liquid water was present	2		4	Borderline requirement for continuous monitoring? If CO2 were not monitored as part of WN/CV monitoring, would GT insist in it?
19.0 Contaminants	The gas shall not contain solid or liquid material which may interfere with the integrity or operation of pipes or any gas appliance	GS(M)R	The gas shall not contain solid or liquid material which may interfere with the integrity or operation of pipes or any gas appliance	More information on contaminants in raw gas and ex treatment. Filtration would be employed, but siloxanes would not be removed.	Solid or liquid enters the network, siloxanes present ex gas treatment		Gas processing failure		2	Expected to be financial if we assume GSMR doesn't cover siloxanes	2		4	Spot sampling required. Frequency will be dictated by concentration in biogas and process plant experience. More work required to set siloxane limit. End of Waste QP may recommend values
3.1 Pressure	That required to deliver flow, subject to not exceeding SOL	GDN LTDS	Depends on pressure at entry point (LP/MP/IP)	7-10 bar at exit of treatment process. Likely to be a pressure reduction requirement.	Low pressure		Plant malfunction	Assumed catastrophic or other	3	reverse flow if pressure reduction valve opens fully to try and maintain pressure	1		3	NRV should be included as standard
3.2 Pressure	That required to deliver flow, subject to not exceeding SOL	GDN LTDS	Depends on pressure at entry point (LP/MP/IP)	7-10 bar at exit of treatment process. Likely to be a pressure reduction requirement.	High pressure		Failure of pressure reduction system		3	overpressurisation of system	1		3	Design should cover this situation
4.3 Odour	No uncharacteristic odour	GS(M)R	No uncharacteristic odour		Gas has an uncharacteristic odour				3		1		3	Suitable primary test point to be identified. Incorporate in routine monitoring.
7.0 Total Sulphur	<50 mg/m3	GDN LTDS and GS(M)R	<5 mg/m3	Validation required of assumption that other S species won't be present	>50mg/m3				3		1		3	Check whether other S species are credible for biogas. If not then perodic spot sampling.
8.0 Hydrogen	<0.1 mol%	GDN LTDS and GS(M)R	<0.1 mol%	Validation required that hydrogen >1% is not credible - Landfill gases might contain H2?	>0.1 mol%				3		1	On basis that raw gas would not contain hydrogen >0.1 %	3	Check whether H2 greater than 0.1% is credible
10.0 Hydrocarbon dew temp	<-2oC at any pressure up to 85 barg	GDN LTDS	<-2oC at any pressure up to 85 barg		>-2oC at any pressure up to 85 barg	Unlikely without triggering other parameters first (ICF, WI)	overdoing with propane		3		1		3	Continuous monitoring not required. Consider spot sampling to verify absence of higher hydrocarbons
15.4 Gross CV	Ofgem directed site - loss of record		Ofgem directed site - loss of record		Loss of record		CVDD failure		3	default daily CV could be 37 MJ/m3. Shrinkage would be small because daily energy is small. Would LSCV become 37MJ/m3??	1		3	Wouldn't recommend duplicate measurement
21.0 Radioactivity	<=5 Becquerels/g	UKD LTDP and Radioactive substances Act (Exemption Order)	<=5 Becquerels/g	not a credible source	N/A		Not credible			3		1	3	Specialist sampling and analysis required. Not a credible source for biogas.
4.2 Odorant	6mg/m3(+/- 2 at DNO request)	GDN LTDS	6mg/m3 variation will be dependent upon exact type of odoriser	Check likely type of odoriser in use	Over odorised at System Entry Point		Failure of odorant injection. Incorrect/failed flow signal on direct control systems		2		1		2	Suitable primary test point to be identified. Incorporate in routine monitoring. Critical sites might demand monitoring of injection rate/integrated rate. Might consider heirarchy of design and monitoring (twin/single stream
5.0 Gas Composition	Ofgem approved Danalyzer ranges	Approval arising from G(CoTE)R	Within Ofgem approved Danalyzer ranges		CO2>7 mol%; propane >7 mol%				1	No Danalyzers downstream of entry point	1		1	

16.0 Energy	1.1% on energy flowrate	ME/1; would e.g. GM/8 be more appropriate? GCOTE requires "requisite to the calculation of FWACV"	Under direction then GM/8 and 2.5% on CV gives 4%	Impact on FWACV is very small, so commercial value of metering gas is the key driver	>4%		1	Impact on FWACV is trivial (e.g. even if 100% innacurate on 10,000 m3/h, then impact on FWACV is trivial).	1	Large CV errors would be unlikely to be unnoticed because of impact on WN	1	Normal commercial accuracy drivers should ensure requisite metering
17.0 Corrected volume	1.0% on corrected volume flowrate	ME/1; would e.g. GM/8 be more appropriate?	GM/8 gives 2% on actual volume ca. 2.5% on converted		>2.5%		1	Impact on FWACV is trivial (e.g. even if 100% innacurate on 10,000 m3/h, then impact on FWACV is	1		1	Normal commercial accuracy drivers should ensure requisite metering
15.1 Gross CV	36.9 to 42.3 MJ/SCM	GDN LTDS - Is this a requirement? Wobbe and ICF/SI would control GSMR compliance			>42.3		1	Excluding impact identified in 15.3	3		3	Consider whether a GCV range should be incuded in the NEA/LTDS
15.2 Gross CV	36.9 to 42.3 MJ/SCM	GDN LTDS - Is this a requirement? Wobbe and ICF/SI would control GSMR compliance			<36.9		1	Excluding impact identified in 15.3	3		3	Consider whether a GCV range should be incuded in the NEA/LTDS
22.0 Inerts	<7 mol%	Only required in some NEAs	<7mol%	raw biogas is not expected to lead to nitrogen content greater than 7mol%	>7 mol%	not considered credible	1	No significant impact identified	1		1	Consider whether inerts requirements in NEAs should be harmonised across the GDNs
											0	
											0	
											0	
											0	
											0	

Risk Assessment_Biomethane_generic

Number	Parameter	Deviation	Impact	Likelihood	Risk
9	Oxygen	>0.2 mol%	3	4	12
12.1	Wobbe No	>51.41 MJ/m3	3	3	9
12.2	Wobbe No	<47.2 MJ/m3	3	3	9
13	ICF	>0.48	3	3	9
14	SI	>0.60	3	3	9
15.3	Gross CV	Situation such that FWACV cap comes into force	3	3	9
1	Delivery Temperature	>20C	3	2	6
2	Delivery Temperature	<0C	3	2	6
4.1	Odorant	Low or no odorant at System Entry Point	3	2	6
6	H2S	>5mg/m3	3	2	6
11	Water dew temp	>-10oC at 85 barg, or whatever value is in specification	3	2	6
20	Organo Halides	Contains significant organo halides	3	2	6
22	Bio-hazards	Contains significant bio-hazards	3	2	6
18	CO2	>2.5% (molar) CO2	2	2	4
19	Contaminants	Solid or liquid enters the network, siloxanes present ex gas treatment	2	2	4
3.1	Pressure	Low pressure	3	1	3
3.2	Pressure	High pressure	3	1	3
4.3	Odour	Gas has an uncharacteristic odour	3	1	3
7	Total Sulphur	>50mg/m3	3	1	3
8	Hydrogen	>0.1 mol%	3	1	3
10	Hydrocarbon dew temp	>-2oC at any pressure up to 85 barg	3	1	3
15.4	Gross CV	Loss of record	3	1	3
21	Radioactivity	N/A	3	1	3
4.2	Odorant	Over odorised at System Entry Point	2	1	2
5	Gas Composition	CO2>7 mol%; propane >7 mol%	1	1	1
16	Energy	>4%	1	1	1
17	Corrected volume	>2.5%	1	1	1
15.1	Gross CV	>42.3	1	3	3
15.2	Gross CV	<36.9	1	3	3
22	Inerts	>7 mol%	1	1	1

	Upper	Lower
Continual	12	6
Periodic	5	4
None / periodic	2	1